Reviews and Bibliographical Notices.

I.—INJURIES TO THE NERVES, AND THEIR CONSEQUENCES.

I. Des Lesions des Nerfs et des leurs Consequences. Par le Docteur S. Weir Mitchell. Traduit et annote avec l' autorisation de l' auteur, par M. Dastre, et precede d' un preface par M. le Professeur Vulpian. Paris: 1874; 408 pages. *(Injuries to Nerves, and their Consequences, etc.)*

II. Traite des Sections Nerveuses. Physiologie Pathologique. Indications. Procedes Operatoires. Par E. Letievant. Paris: 1873; 548 pages. *(Treatise on Nervous Sections, etc.)*

III. De la Regeneration des Organes et des Tissues en Physiologie. Par J. N. Demarquay, etc. Paris: 1874; 328 pages. *(The Regeneration of Organs and Tissues in Physiology.)*

IV. Ueber Nerven Degeneration und Nerven Regeneration. Von Dr. Herm. Eichhorst. Virchow's Archiv, LIX., I. *(On Nerve Degeneration and Nerve Regeneration.)*

The tide of medical literature for a long time—and for reasons not at all to the discredit of a new country, such as ours—has been from Europe to America. But now, as time and opportunity for original research are afforded, contributions begin to flow the other way. The book of Dr. Mitchell's, the title of which stands at the head of our article, is one of the best instances of this fact. It has been widely and favorably noticed, both in Great Britain and on the Continent, but especially the latter. We congratulate the author, on account not only of the compliment done to himself, but to American medical literature, by the present translation, introduced as it is by so eminent an authority in all that pertains to the nervous system as is Professor Vulpian.

We had not proceeded far with a review of the present work for the pages of the Journal, including the preface by Professor Vulpian, when it seemed best, instead of giving a review of our own, to translate bodily the latter, as being not only in the main a full and satisfactory estimate of the work, but also as containing the latest results of his own rare studies in regard to the subject in question. This we do, not to avoid the labor of a notice such as the work merits, but because we think we can perform no greater service for our readers, in this connection, than in giving place to the generous and critical paper of Professor Vulpian. Lengthy as it is, we earnestly commend it to all who feel an interest in the physiology and pathology of the nervous system. It is as follows:

"The nerves form a system of organs altogether peculiar, under all its relations, texture, structure, course and distribution, physiological properties and functions. The injuries which may occur to them must necessarily, therefore, give rise to special changes, and make themselves apparent by symptoms of a peculiar kind. These accidents and these symptoms are almost invariable, at least in their general features, when the mixed nerves are the ones attacked, but are somewhat modified when other nerves are affected; when the lesions, for example, are in the nerves of special sense, or in those of the sympathetic system.

"The idea of combining in one work all the scattered observations on nerve lesions, would naturally suggest itself at some time, to a pathologist, accomplished in physiological researches, and rich in an extended clinical experience of these injuries. No one was better fitted than Weir Mitchell, for such an undertaking. As he explains himself, there was organized in America, during the war of secession, a special military hospital for nervous affections, the direction of which was confided to MM. Weir Mitchell, G. Morehouse, and Keen. To this point were sent, from different parts of the theatre of war, the wounded who suffered from lesions of the nervous system. These physicians had, therefore, under their eyes, the most varied cases of traumatic alterations of the nerves; and they have published their principal observations in a well-known work: 'Gunshot Wounds and other Injuries to Nerves.' Philadelphia, 1864.

"Since then M. Weir Mitchell has not ceased to study this subject, and to collect new material. He has published, more recently, another work, on 'Nervous Maladies Resulting from Lesions of Nerves,' which is included in the medical reports of the National Sanitary Commission. Moreover, he has attempted to test, by numerous experiments on animals, certain results of observations which he has made on the human subject. He is also in possession of the greater part of the needful resources for the attainment of the object in view, that is, to compose a 'Treatise on the Injuries to the Nerves.'

"Yet, in this Treatise, while lesions of the nerves are viewed from a general stand-point, traumatic lesions have furnished the principal contributions. The spontaneous affections of the nerves, while not neglected, are relegated to a secondary position. But far be it from me to reproach the author on this account; I would rather commend him. He speaks especially of that which he has himself observed, and observed well.

"Moreover, among all nervous lesions, those of traumatic origin are the most simple and clear to be understood, and their interpretation is the least the subject of dispute. The idiopathic lesions in general are very different in this respect. If the neuromas up to a certain point have a general resemblance to the traumatic lesions, the case is different with the other affections, the neuralgias, for example. To what kind of nervous lesions are these due? Where are these lesions located? Does it act by a congestion, or an inflammatory irritation of the affected nerve? Is it the nerve trunk itself which is altered? Is it its peripheral or central extremities, or is it the nervous centre?

"While, according to various pathologists, the neuralgias have their usual seat at the periphery of the nerves, or in a part more or less distant from the nervous columns, I believe that, in many cases, the alteration which causes these affections is situated near the central extremities; very often, perhaps, in the spinal cord, or in its membranes. And even in those cases where the neuralgia has clearly for its primary cause a peripheral nervous lesion; in those, for instance, where a decayed tooth, an alteration, perhaps, of the alveolo-dental periosteum, or of the maxillary bones themselves, etc., has given rise to the painful affection, we ought, I think, to admit that, frequently, a little while after the beginning of the trouble, it produces in the nervous centre, or, speaking more strictly, in the focus of origin of the trigeminus nerve, a morbid modification, which exalts to a very high degree the excitability of the anatomical elements of the gray substance. This exaggeration of excitability may extend itself to the elements of the gray substance situated next to those which are directly in relation with the nervous fibres of which the peripheral extremities are affected. The excitation transmitted by these fibres to their origin, propagate themselves to neighboring *foci* of origin; but because of the morbid erethism of these *foci*, the modification which is there determined shows itself by a painful sensation, reported by the sensorium to the periphery of the fibres which take rise in the mass of the gray substance; and it is in this manner that we are enabled to explain the radiation of a dental neuralgia, for example, over the whole corresponding half of the face.*

"It is doubtless because this modification of the nervous centres

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*For this explanation to be admissible, it is necessary to suppose that the various cellular groups of the origin of the trigeminus, selecting this for an example, communicate, the one with the other, by anastomosing conductors. In the normal condition, when one group of cells receives an excitation from the periphery of the corresponding nervous branch, these conductors do not permit a sufficient stimulation of the other groups to make them enter into activity; but it is no longer so when a morbid irritative condition produced in one group invades those adjoining, and their anastomotic conducting elements. These new conditions once established, the excitations produced at the periphery of one branch of the trigeminus can pass, preserving their intensity, from the origin of that branch to the *foci* of origin of the other branches; and, on the other hand, can cause in the one as well as the other, those modifications of functional activity, which we become conscious of as pain.

exists in so many cases of neuralgia, that the treatment by the section of the nerve so often fails. This explanation appears to me at least as acceptable as the one admitted by the majority of surgeons, and which M. Weir Mitchell appears to accept. According to them, the persistence, or the reappearance of the disease, after section of the nerves, in a great number of cases of neuralgia, indicates, perhaps, that the nerve is diseased for a considerable portion of its length, so that after the division an altered portion remains in connection with the nervous centres; or, perhaps, that the alteration commences anew above the section.

"I certainly do not deny the possibility of the existence of a neuritis occupying a part of the course of a nerve in certain cases of neuralgia; but direct search for that morbid condition has too often failed for us to say that a neuritis is the ordinary lesion in neuralgias which are rebellious to surgical treatment. The hypothesis which I have indicated, and which I have developed many times in my lectures, seems to me, on the other hand, to account sufficiently well for all the facts, and may be held provisionally.

"When the neuralgia has for its exclusive cause a central lesion, whatever it may be, it is easy to understand that the section of the nerve which goes to the parts where the pain seems to be, cannot, in general, immediately cure the affection. In fact, the cause exists, and may give rise to painful sensations which will still be felt, by a well-known illusion, as though they resulted from impressions arising in the extremities of the divided nerve. Nevertheless, we should say that, in cases of this kind, the section of the nerve might cause a considerable diminution of the pain, or even make it cease. The section, by interrupting or modifying the physiological relations which previously existed between the central region affected and the periphery of the body, might produce in that region a functional change sufficient to cause the cure, or a more or less marked alleviation of the neuralgia. We will readily admit that matters may so happen, at least occasionally, if we call to mind the instantaneous relief which we so often observe to follow in cases of neuralgia, from the application of agents, either irritant or sedative, over the parts of the surface where the pain seems located. I need only cite one example, that of the terrific pains, more or less continuous, differing from lancinating pains, which are often suffered in the course of locomotor-ataxia, sometimes in one, sometimes in another, part of the body of the patient. These pains, due to a morbid irritative action in the cord, frequently disappear entirely in a few minutes under the influence of topical applications, such as a compress saturated with chloroform, over the part which the patient indicates as the seat of his sufferings.

"If the neuralgia is dependent on a lesion of the extremities, or any other points whatever in the course of a nerve, there are, as I have said, at a certain moment of the development of the affection, two principal factors which concur in its maintenance, the peripheral irritation and the morbid excitability of the central elements for the reception of impressions. Sometimes the division of the affected nerve, by suppressing completely the influence of the irritation of its peripheral extremities on its centra origin, abolishes, immediately and definitely, every symptomatic manifestation, and the morbid excitability of this central *foyer* does not delay to disappear without any question. In certain cases, the nervous section is without any effect, even a temporary one, on the neuralgia. It is presumable, in these, that the section has not intercepted all the routes by which the morbid excitability of this central origin may be put in play. It may be, even, that in certain circumstances, this excitability having continued in spite of the operation, the neuralgic symptoms can still show themselves under the influence, for example, of circulatory disturbances. In other cases, finally, the section only produces a transient cessation of the symptoms; we may then suppose that new irritations, taking rise perhaps from other branches of the same nerve, perhaps from other nerves, it may be from the peripheral extremity of the central portion of the divided nerve, have aroused the morbid excitability of the central elements having relations with the divided nervous fibres. In all probability, the diffuse neuritis plays only exceptionally an important part in cases of this kind.

"We perceive by these considerations, that grave discussions may be raised in regard to the location of the morbid process which gives rise to neuralgias. We can understand, therefore, that we will meet with much that is doubtful, if we attempt to establish the pathology of nervous lesions by the aid of studies made upon the neuralgias.

"M. Weir Mitchell has not found himself confronted by such great difficulties. The locality and the character of the traumatic injuries to nerves are naturally known, and he has, therefore, a solid basis for his deductions. The results furnished by the study of these lesions, are, moreover, not exclusively applicable to themselves. They have a general character, which allows us to use them in the history of other nervous affections.

"M. Weir Mitchell has been enabled to describe, better than any of his predecessors, certain alterations of nerves, in regard to which we have hitherto had only very imperfect ideas. I do not here speak of the congestions of nerves, because that which he has here said on this subject reduces itself, in fact, to the *expose* of experiments made upon animals—experiments that are certainly of great interest, but which are insufficient to make us admit that such a morbid condition can engender, in man, well-defined symptoms. I do not dare to say, like the author, 'that many diseases which we are compelled to call *functional affections*, are allied to this pathological condition, of which we find no traces after death.' I am much more disposed to believe that these affections are due to modifications of the nervous centres; and, inasmuch as the material proof of the habitual coincidence between congestion of the nerves and certain neuralgias has not been given, we ought, it seems to me, to consider this opinion as an unfounded hypothesis. And yet, even when we have proved the reality of this coincidence, it will be necessary to show that the affections concerned, the *functional nervous disorders*, are really due to the congestion, and not, on the contrary, its determining cause; hyperæmia is so often a result of the suffering of the organ in which it makes its appearance.

"But M. Weir Mitchell has studied neuritis in its principal forms, the acute and chronic; and this study is so much the more valuable as respects human pathology, as it has been made entirely by the aid of clinical observations. Experimental pathology has been, and can be here, only a very feeble aid, since it is extremely difficult to provoke, in animals, a true neuritis of progressive march. M. Weir Mitchell has succeeded but once, out of numerous fruitless attempts, in producing an inflammation of a nerve in the rabbit. How many experiments have I not also made in this direction? I have included the nerve in ligatures drawn more or less tightly; or I have pressed it between the point of a forceps; have bruised it, by striking it between two hard bodies; cauterized it with various substances—the essence of cantharides, liquid ammonia, acetic acid. I have pierced it in all directions, with needles, etc., without ever obtaining a true suppurative neuritis extending beyond the points submitted to experimental violence. I have never seen a single case of ascending neuritis of any form in these experiments. As to the lesions recognized in the peripheral extremity, and which offer the characters of interstitial neuritis, that is to say, a multiplication of the elements of the neurilemma and the sheaths, they are in no respect different from the lesions which follow a simple section of the nerve.

"According to the description of M. Weir Mitchell, we see that the neuritis in man has a great tendency to propagate itself from the periphery toward the nervous centre, and to implicate other branches of the same trunk or plexus. This tendency is especially manifest in chronic neuritis. But it is necessary to say that certain cases of chronic neuritis are not mentioned by M. Weir Mitchell. He says nothing, in fact, of the remarkable ascending neuritis noticed by Remak, and well studied by M. Charcot and his students, and which I have often had occasion to verify [I speak here of the neuritis which occurs in cases of descending sclerosis of the cord, following lesions of certain parts of the encephalon]. We are aware that, in these cases, there is a genuine interstitial neuritis, which does not at all necessarily cause the atrophy and destruction of nervous fibres, but which gives rise to an augmentation, more or less considerable, of the volume of the nerve, and is often accompanied with spontaneous pains along its course, with, at the same time, a very lively sensibility to pressure. This lesion shows itself very readily in the nerves of the members. I have many times observed, in the nerves so altered, that mechanical alterations, such as friction or compression of the nerves, not only produce severe pains, but cause, even much more readily than in the healthy state, contractions of the muscles supplied by them. This can be well observed by rubbing the cubital nerve in the olecranial channel in the upper members of a hemiplegic subject. In case the hemiplegia is some weeks old, if there is a certain degree of contraction in the members of the paralyzed side, the friction of the cubital nerve of this side causes not only the painful sensation of numbness extending as far as the ends of the ring and little fingers, but also a rather severe local pain, and, further, contractions in all the muscles innervated by this nerve. On the sound side, on the contrary, the effect is limited in general to the feeling of numbness we have mentioned. I will add, that we can obtain the same muscular contractions, though perhaps to a lesser degree, by rubbing the cubital nerve of the paralyzed side in certain cases of hemiplegia with flaccidity of the members. Ought we to consider that in these different cases there is only an exaltation of the motricity of the nerves? Are the muscular contractions caused by the friction of the cubital nerve exclusively due to a centrifugal excitation, extending from the irritated part of the nerve to the muscles? We will not affirm this. These contractions may, in fact, also result from a reflex stimulation of the muscles innervated by the cubital nerve. We will understand this when we take into account, the exaggerated state of excitability in which we always find the half of the spinal cord on the paralyzed side in hemiplegia; that is to say, the side opposite the seat of the lesion.

"A very interesting chapter is devoted by M. Weir Mitchell to the study of the various forms of traumatic injuries of nerves. He successively passes in review sections (cuts), punctures, contusions, lesions due to luxations, or the operation of the reduction of luxations, those which take place from fracture, and those which are produced by compression.

"Next, he gives the symptomatology of nervous lesions. This chapter is one of the most important in the whole work. After indicating the phenomena manifested at the moment the lesion is produced, he studies the general symptoms which show themselves at the first moment after the wound is received. In a certain number of the cases observed by M. Weir Mitchell, there was immediately a shock or commotion of the nervous system; the wounded person fell, with, sometimes, a loss of consciousness, and sometimes consciousness retained. In some there were immediate intellectual troubles. In all these cases there was evidently a violent shock to the nervous centres; but while in some of the subjects it was, as M. Weir Mitchell says, the cardio-motor centre which suffered the commotion, in others it was the cerebral hemispheres that were affected. The instances of sudden delirium reported by the author, which were produced under the influence of nerve lesions in the superior member, are among the most striking. Other facts ought also to be specially noted, such as those in which we see a wound involving the nerves of one region producing a paralysis in a part more or less distant; a gunshot wound, for example, in the right thigh, involving the crural nerve (observ. 27, p. 161), caused a paralysis of movement of the right arm. This case, and the others which M. Weir Mitchell cites, are examples of *reflex paralysis;* a morbid phenomenon which the author has proposed to designate under the evidently more appropriate name of *paralysis by peripheral irritation.* The theory of these paralyses, as I have myself often remarked, shows, in fact, that no reflex phenomenon is produced in this case. A group of anatomical elements of the cord is struck into inaction by a lesion of a part of the body which appears to have no direct relation with them; hence, paralysis of the muscles, innervated by the nerves, whose functional activity requires the physiological integrity of these elements. There is, in this case, no transmission from the centre to the periphery; everything is confined to an influence toward the centre, reaching and modifying a certain part of the nervous centres; there is nothing of reflex nature. The expression, *reflex paralysis*, should, in the actual state of science, be expunged from the medical vocabulary.

"One of the points of symptomatology on which M. Weir Mitchell most insists, is that relative to troubles of nutrition caused by nervous lesions. The numerous opportunities which he has had for this kind of study, have led him even to give a very detailed description of these accidents, well known to-day in France, thanks to the labors of M. Charcot and his students. He passes in review, also, the alterations produced in the muscles, the skin and its appendages, the connective tissue, and the articulations.

"*A propos* to the alterations which the nails undergo under the influence of nervous lesions, M. Weir Mitchell makes a remark which struck me when I first met with it some months since: 'The nails,' says he, 'continue to grow after section of the nerves; while, in the case of cerebral paralysis, their growth is entirely suspended.' We are well aware that when the nerves of a member are divided the nails may still grow on in a more or less normal manner. Every physiologist has been able to convince himself of this fact; but up to the present we have not observed the arrest of growth of the nails in cases of hemiplegia of cerebral origin. It is a phenomenon difficult to understand, since, in a general way, we see the influence of nervous lesions on the nutrition of parts diminish as they bear less directly on the nerves of these parts, or on the regions of the spinal cord in relation with the origin of these nerves.

"On the other hand, we should say that, if there is no cause of error in the observations of M. Weir Mitchell, it is very probable that he has had under his eyes cases altogether exceptional. I have, in fact, sought myself to test the assertions of the author.

I have blackened, with nitrate of silver, the nails of both hands, as far as they were exposed, of three women in my hospital service, who suffered from hemiplegia, produced by hæmorrhage or softening of the brain: but have observed that their growth continued on the paralyzed as well as on the healthy side. I did not recognize any difference in the nails on the side of the hemiplegia, either in the form of parts turned back or in their growth.

"The observations of M. Weir Mitchell relative to the alterations of the nutrition of the different tissues under the influence of nervous lesions, are very instructive, and serve to call attention to that interesting subject. As regards the mechanism of this influence of the nervous system on the nutrition of tissues, the author speaks only with reserve, and thus gives evidence that he is well acquainted with all the difficulties of the question.

"He examines the two principal theories proposed for the explanation of this mechanism, and adopts neither. Like most physiologists and actual pathologists, he does not imagine that we can account for the disorders of nutrition by making them depend exclusively on modifications of the vaso-motor fibres comprehended in the injured nerves; nor does he any more believe that we are authorized to admit the existence of the *trophic nerves* imagined by M. Samuel. As long as we have been furnished with no proofs of the existence of these nerves, it is best not to base any theories on this hypothesis.

"M. Weir Mitchell is disposed, rather, to regard the trophic influence of the nervous centres as exercised on the tissues through the sensory, or excito-motor, or the motor fibres themselves.

"As regards the influence of the nervous centres on the muscles, it is very probable that this is the case. If the muscular atrophy due to a lesion of a nerve were caused by a physiological modification of the vaso-motor fibres contained in the nerves, and particularly to a *paralysis* of these fibres, the atrophy ought to be so much the less, as the lesions affect the nerves nearer their origin. They receive, in fact, by anastomosis, in various parts of their course, fibres from the sympathetic, containing, according to all appearance, vaso-motor filaments; and experiments confirming this presumption afforded by anatomy, show that paralysis of the vessels, in the parts which receive the ramifications of a nerve, is more pronounced when we divide the trunk of this nerve than when we cut its roots. But it is easy to show that muscular atrophy is quite as rapid and pronounced when we divide the roots of a nerve, as when we divide its trunk. I have demonstrated this in the facial nerve, and, undoubtedly, the result would be the same with any other. I have shown that the section of the facial nerve, made at the level of the floor of the fourth cerebral ventricle, in the immediate neighborhood of the origin of this nerve causes in the muscles of the face an atrophy altogether comparable, in all respects, with that which is produced when we cut the facial at the level of the masseter muscle.

Besides, lesions which rapidly destroy the cells of the anterior cornua of the cord, produce as rapid and profound an atrophy of the muscles innervated by the nerves in relation with these cells, as would a traumatic lesion interrupting the continuity of these nerves at any point whatever of their course. It is this which we have identified, for example, in cases of infantile atrophic paralysis, or in those atrophic paralyses in youth or adult age consecutive to various affections, eruptive diseases among others.

"It is not the paralysis of the vaso-motors, therefore, that causes the atrophy of the muscles following lesions of the nerves distributed to these organs. And this proposition hardly needs special proof, since innumerable physiological observations have shown that paralysis of vaso-motor fibres does not cause atrophy of the muscles in relations with them; for example, I have never seen an atrophy of the muscles of the head produced in animals after division of the cervical sympathetic, or laceration of the superior cervical ganglion.

"It seems to me, that the well-known facts that I relate may also be invoked to show that the muscular atrophy dependent on sections of nerves, does not have for its cause an *excitation* of the vaso-motor fibres, with constriction of the vessels, diminution of the afflux of nutritive material, and destruction of muscular elements. Further, if we study in each case of nervous section the state of the circulation in the parts which the nerves supply, we easily recognize that the vessels, at least in the first period, dating from the moment of the lesion, are dilated, rather than constricted. There are seen, to a certain degree at least, the same phenomena as those which we observe over one whole side of the head, when we have divided the cervical sympathetic of that side; and *a priori* these are then the conditions of an exaggeration, rather than a diminution of nutrition.

"Therefore, the muscular atrophy produced by nerve lesions cannot be attributed to modifications of the vaso-motor influence of the nervous centre on the muscles; and consequently, we have to admit that this atrophy is due to modifications of some other influence exercised on the muscles by the nervous centres and nerves.

"But great difficulties yet remain. We are compelled, in fact, to demand if the muscular atrophy is produced in these cases by an enfeeblement or by an exaltation of the influence in question. Let us see if it is possible to explain the muscular atrophy by admitting that, when the nerve is completely divided, it depends on an irritative action provoked in the tissues of the muscles by a traumatic excitation of the peripheral extremities of the severed nerves.

"First, how are we to suppose that a traumatic, inflammatory excitation of the divided nerves, allowing that a phlegmasic excitation, with all its characters, does there exist, can yet produce and maintain any irritation whatever in the muscles, when these nerves, at the end of a few days, have incontestably lost their physiological properties with their normal structure? And then it is needful to note that the atrophic alterations of the muscles which take place when their nerves are cut, presents only imperfectly the characters of irritative lesions. It shows, it is true, a multiplication of the nuclei, or cells of the primitive muscular bundles; a thickening of the internal perimysium and of the sarcolemma; and these are of the character of irritative lesions; but the principal modification, the progressive shrinking of the muscular bundles, is purely atrophic. As this shrinking also occurs in the bundles the nuclei of which are least multiplied, and which are not surrounded by noticeably thickened sheaths of connective tissue, we cannot consider it, in general, as the result of a crowding out of these elements by inflammatory neoplastic products. The vessels of the muscles undergoing this atrophy do not present, in these cases, constant and obvious lesions, so that the atrophic alteration cannot be considered as due to modifications of the vascular walls embarrassing the nutritive changes that ought to take place between the anatomical eleménts of the muscles and the blood of these vessels. When atrophy of the muscles takes place, after the complete section of its nerves, this alteration does not result, therefore, from any irritative inflammatory lesion, either of the muscular elements themselves, the interfascicular tissue, or the muscular vessels. Further, I repeat, this morbid action, whatever its nature may be, cannot be provoked at a distance in the muscles by irritation of the divided nervous fibres. All that I have said of the cases where the nerves were cut completely across, necessarily applies to those in which only the medullary centre is fully destroyed; for, as we know, the nerves are altered in the same manner as if they had been completely divided.

"But the conditions are not identical, we will say, when the muscular nerves suffer an injury which does not entirely interrupt their continuity, or when their nucleus of origin is only partially affected. Can it not, in this case, through irritation of the nerves, or their origin, produce, either in a direct or reflex manner, and by the intermediation of fibres remaining intact, a morbid super-excitation of the muscles, there producing an irritative action, which results in muscular atrophy?

"Where are the proofs establishing the possibility of such a mechanism? What would be the morbid super-excitation which we are to suppose may enter into action in these cases? It would evidently not be a super-excitation of the muscular contractility. In the immense majority of cases we see nothing like it. The muscles, or certain of their bundles, are paralyzed, and not contracted, either during the first period of the atrophy, or during its whole action; and in those cases where spasmodic contractions are exceptionally produced, under the influence of partial lesions of the nerves or the nervous centres, this condition cannot be considered as a cause of the atrophy. Some muscles may be kept contracted for many weeks, on account of lesions which cause a lasting excitation of their nerves, without, at the end of that time, any manifest signs of atrophy. We have frequently had occasion to observe this in hysterical patients, and sometimes in those not hysterical, but resembling in their general appearance cases of tetanus. I have recently had under my observation in my service at La Pitie a case of this kind. In an adult and vigorous man, a permanent contraction of the muscles of the two lower limbs lasted over three months, without their showing any appreciable diminution of volume.

"If we cannot explain by a super-excitation of the muscular contractility, in the cases of partial nervous lesions, the atrophic influence of the supposed irritation of the nerves and the nervous centres, is it to be explained by a morbid superactivity, more or less perverted, of the nutrition? But the modifications of the structure of the muscles do not present in these cases, any more than in the others, at the moment of their evolution, the characters of an actual irritative lesion; and, moreover, there is a perfect identity between the two categories of cases, as regards the form and progress of the muscular alteration. It is, therefore, correct to assume that this alteration is due to one and the same mechanism in both; and that in these cases the muscular atrophy does not have for its cause an irritation of the nervous elements in relation with the muscles.

"If the atrophic alteration of the muscles is not caused in these different cases by the irritation of the injured parts of the nervous system, it is produced, apparently, in consequence of a diminution or an abolition of the physiological activity of the nervous elements in relation with the muscles. It is in this way that we are obliged to explain not only the atrophy produced in the muscles to which the affected nerves are distributed, but also the so-called reflex muscular atrophies which appear in the course of neuralgias, and even, as I shall explain farther on, those which appear at a distance, in muscles not in any direct relation with the nerves originally affected, it may be in the injured limb, perhaps even in another.

"But what is the mode of influence of the nervous system the suppression or enfeeblement of which involves the production of atrophic alterations of the muscles? Is it the motricity of the nervous elements, or some other physiological aptitude pertaining to them?

"Various pathologists have denied that the functional inertia of the muscles, caused by the section of their motor nerves, or by the destruction of the intra-medullary origin of these nerves, was the cause of the muscular atrophy in these conditions. We may object to this supposition that the functional inertia of the muscles exists, also, in cases of hemiplegia in which the paralysis is complete; and that it also exists in paraplegia, where a compression of the upper part of the dorsal cord prevents all voluntary movements of the lower limbs; and that, nevertheless, we never observe in these cases any atrophy comparable to that produced by division of the nerves or destruction of the cells of the anterior cornua. This objection, it is necessary to say, has only a relative value; because, in these cases, reflex movements can still take place in the paralyzed parts, the immobility of the muscles is, therefore, not as complete as when their nerves are cut, or when the *foci* of origin of these nerves are destroyed.

"It is, therefore, impossible, as regards the muscles, to completely refute the opinion which attributes to their functional inertia a principal, if not an exclusive, part, in the production of muscular atrophy, under the influence of nervous lesions.

"But we may apply to the muscles, by analogy, the conclusion at which we arrive, when we examine the influence of this functional inertia on the alterations of nerves separated from their centres. We know that we have desired to attribute, also, to this cause, the atrophy of nervous fibres which takes place under these conditions; but, as I have already remarked, this hypothesis cannot be sustained.

"First, as regards the motor nerves, we see the peripheral portion of certain ones among them recovering completely its normal structure and properties, after previous alteration, even when its function had been completely abolished. It is this which happens, for example, in the hypoglossal in the dog, when, having cut the nerve across, we completely tear out its central segment with its medullary roots.

"On the other hand, as regards the sensory nerves, we can invoke the same argument, drawn from experiments of the same kind made on certain of them, on the lingual nerve, for example; but we can support ourselves on at least one other fact quite as decisive.

"When we cut across a sensitive nerve, its peripheral segment undergoes, like that of a severed motor nerve, a process of atrophy along its whole length; this is the case, as Waller has shown, when the posterior root of a mixed nerve is cut between the corresponding rachidian ganglion and the point where it joins the anterior root to form the nerve; the portion of the root comprised in the space between the section and the junction of the two roots becomes atrophied, and the alteration extends along the sensitive fibres of the mixed nerve to their extremities. We may admit that, in such conditions, the sensitive fibres are, from the instant of the section, in a state of complete functional inertia, although that may be disputable, since peripheral impressions may yet, inasmuch as these fibres are unaltered, cause an ascending modification. The functional inertia being conceded, we can attribute it to the atrophy of the nervous fibres detected in these experiments. But what of this explanation when the section of the mixed nerve is made between the rachidian ganglion and the spinal cord?

"Waller has shown that when the experiment is so performed, the peripheral segment of the posterior root, that which is yet in connection with the rachidian ganglion, remains intact, and that the same is the case with the fibres beyond the ganglion, as far as their peripheral extremities; while, on the other hand, the central segment of the root, that which is yet in connection with the cord, is altered, and undergoes an atrophic degeneration; and yet the sensitive fibres in their whole course between the point of division and their peripheral extremities, are in the same condition, as regards their functions, as when the section is made between the rachidian ganglion and these extremities.

"As we are aware, Waller, led by these experiments, considered the ganglion of the posterior roots as the trophic centre for the sensitive fibres; while, according to his researches, the gray substance of the cord is the trophic nucleus for the motor fibres.

"These experiments are of the utmost value for our discussion; they prove that functional inertia cannot be invoked to explain the atrophic alterations of divided nervous fibres, since they can exist, in the same degree, in fibres that are atrophied, and in others which are not.

"If we are not authorized to attribute to functional inertia the atrophy of the nerve fibres which takes place in the peripheral segment of a nerve separated from the nervous centres, why shall we adopt that theory for the muscles? Does not the rapid march of the alterations in the muscles, that are cut off from the influence of the nuclei of origin of their nerves, disagree with such an explanation? Fifteen days suffices to produce a very recognizable atrophy in that half of the tongue, the corresponding hypoglossal nerve of which has been cut, and this atrophy is quite considerable at the end of five or six weeks.

"We can, therefore, conclude, without being able to always prove it as clearly as in the case of the nerves, that muscular atrophy does not depend directly on the functional inertia of the fibres in connection with these organs. It is therefore to the suppression of some other influence exercised in the normal condition by the nervous centres on the nerves and muscles, that we have to attribute the atrophic alterations which are developed in these organs after they are separated from these centres. What is this influence? It is impossible, in the present state of our knowledge, to convey a clear idea as to its nature; and we are compelled to designate it by a particular name. The word *trophic*, already employed by Waller, seems to us sufficient. We say, therefore, that the nervous centres exercise over the tissues, and particularly over the nerves and muscles, a *trophic influence*; and that it is the enfeeblement or abolition of this influence that causes the atrophic alterations of nerves and muscles when the connection of these organs with the nervous centres are broken or simply diminished. But we do not consider that this influence is exercised by the intermediation of particular nervous fibres, having a special functional *role;* it is not transmitted to the nerves and muscles by distinct *trophic* nervous fibres, constituting the *trophic nerves* of M. Samuel.

"This *role* is not one of the physiological attributes of the sympathetic nerve fibres. Among the reasons that I have given for rejecting the intervention of the vaso-motor fibres, are two which I will repeat in this place: on the one hand, is the fact that the section of the cervical sympathetic of one side, and the laceration of the corresponding superior cervical ganglion, never causes an atrophy of the deep or the superficial muscles of the corresponding half of the head; and, on the other hand, the second fact, that the division of the root of the facial nerve in the medulla itself produces, in the face, an atrophy exactly like that which follows the division of the same nerve in front of the parotid gland, although the nerve between these two points receives numerous anastomotic filaments from the sympathetic.

"We are therefore led to think that it is the musculo-motor fibres themselves that carry to the muscles the trophic influence of the nervous centres; and this, as we have said, is the opinion of M. Weir Mitchell.

"Injuries of nerves cause not only the so-called reflex paralysis, they can also provoke muscular atrophies at a distance; and these accidents, studied already by various authorities, have also been designated by the name reflex. M. Weir Mitchell speaks of these atrophies in many passages of his book, and inclines to consider them as produced by an ascending propagation of an inflammation of the nerves, the irritation passing from the nervous cord directly affected to other branches of the trunk from which this cord arises, or even to other nerves of the plexus which it aids to form. I believe that, in the cases where the atrophy at a distance is considerable, it depends, ordinarily, not on the cause supposed by the author, but on a modification produced, under the influence of the injured nerve in a more or less distant portion of the gray substance of the spinal cord. And it is not impossible, even, that, in certain cases, this modification may show itself in a part of the gray matter very distant from that which gives rise to the nerves primarily affected. Experimental physiology shows, in fact, that lesions of the nerves may influence regions of the spinal cord very distant from that which contains the focus of origin of these organs. As M. Brown-Sequard has shown, the division of the sciatic nerve in the guinea-pig can cause, in the medulla oblongata, and, probably also in the upper portion of the cervical spinal cord, morbid modifications, which engender epilepsy, on one hand, and, on the other, give rise, under the same conditions, to the appearance of the cutaneous epileptogenic zone on the postero-inferior region of the face, and the superior lateral portion of the neck. A fact like this, so well established, authorizes us, it appears, to admit that, in certain cases, there can also be produced, under the influence of injury to the nerves of a member in the gray substance of a medullary region far removed from that which gives rise to these nerves, a more or less profound alteration, resulting in the atrophy of the muscles whose nerves are supplied from the region last attacked.

"When the muscles which are secondarily atrophied are innervated by nerves forming part of a trunk or plexus whence is derived the nerve directly injured, it will be the modification produced in the seat of origin of this nerve, which extends itself to the neighboring parts of the gray substance; it next produces a centrifugal alteration in the whole, or, more frequently, in one portion of the trunk or plexus of which the nerve made part, and, at last, an atrophy of the muscles supplied by these nervous fibres so attacked. In some cases, where I have cut, in guinea-pigs, the great sciatic nerve in the middle of the thigh, I have seen the small sciatic nerve, which had not been touched, undergo, at the end of a certain time, a quite pronounced simple atrophy; and M. Brown-Sequard has shown, in cases of the same kind, that muscles corresponding also to uninjured nerves, may become atrophied in a very remarkable manner. He would evidently not have the least difficulty in admitting that these phenomena may occur, under these conditions, in man as well as in the lower animals.

"The alterations which the cutaneous integuments may present, in cases of injury of nerves, have been studied with especial care by M. Weir Mitchell. The mechanism of their production appears to me even more obscure, if possible, than that of the muscular alterations. It is difficult, here, to reproduce in animals the results which we observe in man. It is rarely that we are able, by means of injuries to the nerves or the nerve centres, to produce on the usual subjects of vivisection (dogs, cats, rabbits, and guinea-pigs) cutaneous affections similar to those we see appear in man, following lesions of the nervous system. The most of the eruptions we have observed on animals that have undergone the operation of dividing certain nerves, the sciatic nerve, for example, were developed beyond the limits of the region supplied by the injured nerve. As to myself, I have never seen any true eruption on the member corresponding to the cut sciatic nerve. Among all the numerous animals in which I have divided this nerve, I have caused, in some cases, the falling out of the hair; and very often, the only lesion of the skin—a very inconstant one, moreover—has been the formation of eschars from undergoing pressure, either from within or from without. Light on this question, from experimental pathology, is, therefore, almost absolutely lacking.

"Is it, then, to the paralysis of the nerve fibres going to the integument, that we are to attribute the development of the diverse affections of the skin and its appendages, observed in consequence of injuries to the nerves? Or do they take place, on the other hand, under the influence of an irritation of these fibres? M. Weir Mitchell adopts this last view; and, supporting himself by the fact that the cutaneous alterations are, in general, more considerable in cases of incomplete than in complete section, he thinks that, most frequently, they are the result of a reflex irritation of the integument. One other consideration pleads, also, according to him, in favor of this hypothesis: the alteration of the cutaneous surface ordinarily appears but slowly.

"Nevertheless, it is necessary, I believe, not to go too far, and, without making serious reservations, to attribute the alterations of the skin and its appendages, in cases of nerve lesions, to a state of neuritis or of sclerosis in the affected nerves. Besides, M. Weir Mitchell only regards these morbid conditions of the nerves as the *more frequent causes* of the alterations, and considers that, in certain instances, they may be due to an interruption of the nervous relations between the integuments and the nerve centres.

"For my own part, I believe that it is, on the other hand, to this interruption, more or less complete, that we must usually attribute the production of these alterations. They appear to me to be due, at least in most cases, to an enfeeblement or an abolition of an influence exercised by the nervous centres on the nutrition of the skin, an influence analogous to, but less powerful than, that which these centres exercise on the muscles and nerves.

"This influence is transmitted, without doubt, to the skin, by the sensitive fibres themselves; and there is no need of admitting, here, the existence of special trophic nervous fibres, after we have already rejected them in the case of the muscles. It is necessary to see that there is, then, no special difficulty. That the sensitive nerves transmit the *experimental* excitations only in the centripetal sense, or in both centripetal and centrifugal, or that the exclusive route of the transmission of the excitations, *in the normal conditions of the functional activity* of these nerves, may be centripetal, is of small importance. It is certain that the trophic influence of the nervous centres may be carried centrifugally by the sensitive nerves; and a better demonstration of this than we can give is furnished by observing the atrophy which shows itself in the sensitive fibres themselves, when they are separated from their trophic centres; that is, between their rachidian ganglia and the periphery. It is the peripheral portion that is altered in this case; it is, therefore, that portion that is withheld from the trophic influence of the ganglion, this influence being centrifugally transmitted to that part. If the trophic influence of the ganglia of the posterior roots is carried to sensitive fibres associated with motor ones in a mixed nerve, following a centrifugal course, it may, following the same direction, propagate itself as far as the cutaneous integuments.

"Therefore, in my opinion, the alterations of the skin and of its appendages, the subcutaneous cellular tissue, etc., originating under the influence of those of the nerve centres, rachidian ganglia, and bulbo-spinal axis, depend, most frequently, if not always, on a diminution or a default of trophic action of the nervous centres.

"There can be no doubt, it seems to me, in regard to the atrophic and necrosial alterations of the tissues in question. These alterations are most plainly produced when the tissues are entirely cut off from the trophic action of the centres; and vivisections prove that, when they take place under these conditions, they show themselves so much the more promptly, as the cessation of this action is sudden and complete. In fact, among all the lesions that the nerves can be made to undergo, it is the section or the laceration—the rupture, in short—of these cords, that causes the most rapid and extensive alterations of the skin and subjacent tissues (œdema, sphacelus).

"As to the other alterations, they comply better with the hypothesis of an exaltation of the trophic action of the nervous centres. I would speak here of the various herpetic, vesicular, and bulbular eruptions, which we observe in these conditions; of the cutaneous ulcerations, whitlows, and one form of alteration which MM. Mitchell, Morehouse, and Keen, have made better known to us than their predecessors, describing it under the name of glistening aspect of the skin. In most cases, all the relations between the localities of the cutaneous affections, on the one hand, and the central parts of the nervous system, on the other, are not absolutely broken. We may, therefore, suppose that the morbid excitations provoked by the inflammatory action in the part of the nervous system which is subjected to an injury, traumatic or otherwise, causes in the trophic centres of the sensitive nerve-fibres, that is, the ganglia of the posterior roots, an irritation that is reflected by these fibres toward the periphery. We may suppose, also, with M. Weir Mitchell, that, in a certain number of cases, the excitation originating at the point of the nervous system, or the locality of the primary lesion, acts directly, in a centrifugal sense, on the nutrition of the skin and other tissues, by irritating them, and so causing the development of the alterations in question. But these hypotheses are far from being yet proven. It is possible that there is, in these cases, simply a disorder of nutrition (dystrophia) caused by a diminution of the central trophic influence. I am well aware that the appearance of these cutaneous alterations is often preceded, or accompanied, by symptomatic phenomena, pain, for example, indicating a more or less intense irritation of those parts of the nervous system suffering injury. But cannot we admit, simultaneously with these phenomena, and perhaps from the same cause, an enfeeblement of the trophic action of the centres?

"We may, therefore, if this method of reviewing the question be correct, embrace in one general formula all the pathogenetic conditions of the alterations which are brought about in the muscles, the skin, and the other tissues, under the influence of injuries to the nervous system. We can say that these alterations are the result of disorders of nutrition, due to the abolition or diminution of the trophic action of the nervous centres on the different tissues.

"M. Weir Mitchell has not neglected any part of his subject; therefore, we find in his work valuable information in regard to the influence of nerve lesions on the sudoriparous glands, on the subcutaneous connective tissue, on the articulations, and on the modifications of temperature that are produced in parts of the body supplied by the affected nerves. He describes the effects of injuries of nerves on the functional action of the muscles; next, he studies the disorders of sensibility induced by these lesions. This study is full of interest. All the modifications of sensibility which present themselves in cases of nerve injury are passed in review and subjected to a very delicate physiological analysis.

"M. Weir Mitchell has met with cases analogous to those long known, in which a traumatic violence acting on the nerves of a member, destroys the power of motion in a certain number of muscles, leaving more or less intact the cutaneous sensibility of the corresponding region. The experiments of MM. Arloing and Tripier* put us in a position to-day to explain these facts, by showing us that if a mixed nerve, the cubital, for example, is divided, the region of the skin to which this nerve is distributed does not completely lose its sensibility on account of the anastomoses, very variable, moreover, that are furnished to the extremities of this nerve by the other sensitive nerves of the arm; the muscles supplied by the fibres of this nerve, on the contrary, are necessarily paralyzed, because the arrangement that exists for the cutaneous nerves is not, also, common to the muscular nerves.

"It is in this way, also, that we can explain, at least in certain cases, the more rapid return of the sensibility than the motility. It is probable that the cutaneous anastomoses of the fibres of a nerve, of the arm, for example, permit, in some cases, the prompt re-establishment of a certain degree of sensibility, if there has been complete anæsthesia and paralysis of motion on account of an injury to the nerve which supplies this part. But there is still another condition which accounts for this peculiarity, when the sensibility remains abolished for some weeks. When a mixed nerve has been cut transversely, we know that the muscles innervated by this nerve undergo atrophic alterations, which may become extensive if the reunion of the two parts of the divided nerve does not soon take place. The regeneration of the muscles only commences when the continuity of the nerve is re-established, and its peripheral portion has recovered its structure and functions. This muscular regeneration demands for its accomplishment a considerable period, the longer in proportion to the length of time that the division has existed.

"We understand, therefore, what should take place at the time when the reunion of the two segments of the nerve, and the restoration of its peripheral portion are sufficiently advanced to allow the passage of excitations throughout its whole extent. The sensibility will readily be re-established in the cutaneous region supplied by the severed nerve, because the skin, on the one hand, and the spinal cord, on the other, have undergone only slight modifications, while voluntary motion is still for some time difficult and feeble, because the work of muscular regeneration only really commences at the time of the reunion of the parts, and is perfected but slowly. These muscles, therefore, remain for some time in a more or less marked state of atrophy, and respond to the excitations of the will only by feeble contractions. The difficulty of voluntary motion depends, also, on the modifications that are produced in the fibrous or tendinous parts of a member, when the paralysis caused by the division of its nerves has been of long duration.

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*I have repeated the experiments of these physiologists for the commission of the Institute, who were charged with the examination of their work, and have proved that they give the results these authors claim.

"When nerves suffer a powerful compression, or a violent contusion, that portion lying between the point compressed or contused and the periphery, undergoes an atrophic alteration quite as complete as in the case of their section. But in this case, inasmuch as the continuity of the fibres is interrupted, without the nervous cord itself being divided, this continuity may be rapidly re-established. The muscles are still very little altered when the transmission of the excitations again become possible; the power of voluntary motion may, therefore, promptly regain its normal condition. It is plain, moreover, that if, from any cause, the restoration of the peripheral segment is hindered, in cases of contusion or compression, the conditions approach those produced by the complete division of the nerves, and the restoration of voluntary movement will be quite as gradual in the one case as in the other.

"I have already developed these considerations in other works, and need not dwell on them farther. M. Weir Mitchell calls them in, also, to explain the difference which exists, as regards rapidity, between the return of sensibility and that of motility, in certain cases of injuries to nerves.

"According to him, this difference finds, also, a *raison d' etre* in the different conditions of the skin and muscles, as regards their natural excitants. The skin undergoing, without cessation, the diverse excitations produced by external agents, will always preserve its active excitability, and re-assume its functions as soon as the transmission of impressions from the centres again becomes possible; the muscles, on the other hand, when deprived of their physiological excitants, that is to say, the motor excitement emanating from the cerebro spinal axis, become less and less excitable, and answer to that incitation only with great difficulty when the continuity of their nervous fibres is re-established.

"This hypothesis, ingenious as it is, seems to me hardly acceptable; besides, it is perhaps needless, when we are able to explain the facts in question very clearly by means of the physiological facts I have given.

"The chapters that M. Weir Mitchell devotes to the treatment of injuries to the nerves, merit all the closest attention of the reader. The various indications furnished by the circumstances of the lesion, by its nature, by its primary or secondary symptoms, and by the later accidents to which it may give rise, are all successively examined with the greatest care, and the author gives a very judicious statement of the therapeutical resources, which the physician may employ to meet each of these indications.

"The author next examines the lesions of certain spinal nerves: the great sympathetic, the facial, the motor oculi, and the trigeminus. Finally, in the last chapter, he traces the history of the nervous affection of stumps after having shown the functional and other modifications which take place after amputations.

"We find in this chapter an extremely interesting study of the illusions and sensorial hallucinations in regard to the amputated part. M. Weir Mitchell has had frequent occasions to observe these phenomena; he has noted various remarkable peculiarities, among which we cite the two following: In a case of amputation of the leg, in which the illusory sensations of the absent foot had almost entirely disappeared, he saw a second amputation, performed higher up on the same limb, cause them to be renewed. On the other hand, in subjects who no longer experienced the sensation of the amputated limb, he was able to make them reappear by electrizing the nerves which supplied the stump.

"The principal affections of stumps, indicated by M. Weir Mitchell are, neuralgias and chorea of the stump. The author attributes neuralgia of the stumps to an ascending neuritis. I have already explained my position in regard to this theory. If we can really refer these neuralgias to neuritis in some cases, it is yet very probable that they often have another cause, at least, in part. As I have said, according to all appearance, there is produced in these cases a morbid modification of the gray substance of the regions of the spinal cord, which give rise to the divided nerves. This morbid modification, in certain cases of amputation, brings on neuralgia, even when the inflammatory irritation of the extremities of the nerves of the stump has disappeared; and this is the reason why the section of these nerves, performed in order to remedy this neuralgia, produces no lasting cure, and may not even procure a temporary relief. As to the *chorea of the stump* (the author designates under this name an affection which is described by no one before him), I have no doubt but that it also depends on a morbid modification of the gray matter of the spinal cord; only this modification is different, either in nature or location from that which I have mentioned in regard to the neuralgia; but, in certain cases, the two can coexist, as prove the cases in which M. Weir Mitchell observed the choreic spasms of the stump at the same time with a more or less violent neuralgia.

"In what do these morbid modifications of the spinal cord consist that give rise to either neuralgias or chorea of the stump? We cannot tell. Perhaps the wasting, which in all cases of amputation takes place in the region of the cord, in connection with the nerves of the member operated on, creates a predisposition favorable to these modifications.

"This superficial examination of the work of M. Weir Mitchell, cannot give any correct idea of its value. I have allowed myself to bring into special prominence certain points of physiology and experimental medicine, and these are assuredly the less important points of this work. All questions bearing on pathology are treated in the most instructive manner. The various results which are established are supported by numerous observations, nearly all collected by M. Weir Mitchell, and given either in brief or *in extenso*.

"The book, which is very easy reading, as is usually the case when the authors speak of what they have themselves observed, will be consulted with the greatest profit by the physiologist, the physician, and the surgeon.

"The editor, M. G. Masson, has done us a real service in publishing a well-made translation of this remarkable memoir."

With the views expressed in this admirable paper we heartily agree, especially in the stress that is laid on changes in the nerve centres, rather than the nerve trunks, as the pathological basis or essential condition, not only of most neuralgias, but many other affections involving the nervous system. We had intended to speak of certain points in Dr. Mitchell's work not adequately noticed by M. Vulpian, but the length of this notice already, induces us to postpone any further remarks until a future number of the JOURNAL.

Very appropriately following a notice of Dr. Mitchell's work, we may pass to an examination of that of M. Letievant. It is divided into three parts. Part first is devoted to the "Physiological pathology of nerve sections." In the second part, the "Surgical indications of nervous sections in man," are considered; and in the third, or final part, "Operative procedures" are described. This last, falling within the limits of operative surgery, it is not our intention to examine; nor, indeed, does a review of the second part come within our plan.

The work opens with a brief historical sketch of the literature bearing on the subject of nerve sections; then follows a statement of the plan of the work, and a full sketch of the bibliography of the subject, the latter occupying almost seven pages. Then our author enters abruptly on his work. He says:

"I will expose, first, the physiologico-pathological phenomena consecutive to division of the median nerve. This study will permit me to establish firmly certain points of the theory of motor and sensitive substitution, or vicarious supply (*suppleances motrices—et sensitive*), a new theory, destined to throw a strong light on the study of other nervous sections. The doctrine once established, I shall describe, successively, the phenomena which result from section of the ulnar and radial nerves, the principal nerves of the inferior extremities, and those of the face."

After this statement, the author begins to relate cases as a basis for his theory. They are twenty-five in number, and are drawn from a great variety of sources, some of them being cases observed by M. Letievant himself. They are, all of them, instances of real or supposed complete division of the median nerve. The results of a careful analysis of these twenty-five cases are summed up as follows: "Section of the median nerve does not involve either profound change in the tissues, nor an absolute paralysis of sensibility, nor of motility, in the parts to which it is distributed;" and, we may add, to which it alone is distributed. Now, the question is, how it comes to pass, if the median nerve has been completely divided, that parts that seem to be supplied by it alone, retain or recover, notwithstanding, a measure of sensibility and motility. There are just three ways, according to M. Letievant, in which such phenomena may be explained. They may be explained by supposing the nerve to have been repaired or *regenerated;* or we may explain them by supposing the nerve not fully divided. Some fibres belonging to the median must be left as conductors of motor and sensory impressions. But a consideration of M. Letievant's cases, we think, will leave no doubt that both these modes of explanation are inadequate. The third mode of explaining the phenomena in question, is that proposed by M. Letievant himself, and which he calls the theory of *substitution* or *vicarious supply.* It is this: In case of the sensibility which remains, after division of the median nerve, for example, in parts innervated by it, the route for sensory impressions is not the median, but through anastomotic fibres, which extend between the median and the ulnar and radial nerves. Among other proofs that such an anastomosis exists, he cites a rather striking experiment of MM. Arloing and Tripier. He says: "Those two authors divided, successively, three collateral nerves on the toe of a dog. Sensibility to pain persisted on all parts of the toe. They then divided the fourth collateral nerve. The analgesia became absolute. They were then able to prick or tear the toe of the animal, without the slightest evidence of pain. Before the section, the fourth collateral was sufficient to establish a relation with the nervous centres. On it alone, depended as well the parts of the member to which it was not distributed as those to which it was. This is an incontestable example of sensibility by anastomotic substitution." (P. 48.)

Moreover, our author, besides giving experimental and pathological proofs of his theory of substitution, refers to the anatomical proofs of anastomosis, between the median and adjacent nerves. We suppose impressions made on the *trunk* of the median to be conveyed by these large anastomotic branches, which pass between the median and the ulnar and radial nerves. But, without following into details, we must say his theory of substitution does not satisfy us entirely. We believe the connections of sensory nerves in the skin may be such as to enable the radial or ulnar nerves, for example, to convey, in an imperfect manner, the sensory impressions, the direct and normal routes of which, to the nerve centres, would be the median nerve. In this respect, we conjecture, the arrangement at the periphery of a sensory nerve is much the same as at its central termination, where a nerve fibre connects with a nerve cell; and this, in its turn, with many others: so, that if the direct route of transmission is interrupted in the centre, provision is made for a more circuitous and less perfect one; and an opinion not far from this seems, at least, to constitute the main feature of M. Letievant's theory of nervous substitution.

Though we do not remember to have met with the idea of substitution, in the action of the peripheral nervous system, so definitely stated as it is by M. Letievant, yet the idea is not a novel one in the physiology in the nervous system, and we cannot share fully in the enthusiastic expectations of its author as to its value in nervous pathology.

As to the remainder of this first part of M. Letievant's book, it consists in a detailed account of the effects following division of the nerves of the face and of the inferior members. They relate to changes in the motility, sensibility and nutrition of parts dependent on the nerves in question, which are essentially the same as those related as following division of the median nerve.

The work is especially of interest to the surgeon, but contains many facts relating to the effects of nerve sections on the nutrition of parts which are of interest to the neural pathologist. But phenomena of this latter class it is our design fully to discuss in a future number of the JOURNAL, and so we pass them by for the present.

As regards the last two monographs, they relate to purely intrinsic nerve changes, rather than to the extrinsic effects of nerve lesions. They are highly important. But the present article has so much exceeded the limits intended at first that we must postpone a consideration of them until a future number of the JOURNAL.

II.—RECENT WORKS ON MEDICAL ELECTRICITY.

I. PRINCIPES D'ELECTROTHERAPIE. Par Dr. E. Cyon. Paris: 1873. 274 pages. *(Principles of Electro-therapy.)*

II. NERVENPATHOLOGIE UND ELEKTROTHERAPIE. ZWEITE AUFLAGE DER ELEKTROTHERAPIE. Von Dr. Moriz Benedikt. I. Abtheilung. Leipsic: 1874. 395 pages. *(Nerve Pathology and Electro-therapy. Second Edition of the Electro-therapy. Part I.)*